and orbit gear 6 could have slightly crowned teeth instead of or in addition to the crowned teeth on planet gears 3 within the principles of the invention. The crowned shape of the toothed flanks on planet gears 3 may be circular, arc-shaped, elliptical or shaped in accordance with other appropriate boundary lines.

As shown in FIGURE 3, extension 11 of orbit gear 6 is provided with apertured portions 16 so that the annular surface of extension 11 is interrupted, preferably in symmetrical arrangement. Thus, a structure is obtained according to which orbit gear 6 is connected with the portion of extension 11 carrying coupling teeth 12 by means of a number of thin-walled arms 16*a* which are non-resistant to bending so that elastic deformation of orbit gear 6 as caused by radial forces on the teeth will not be substantially affected.

In operation of the embodiment shown in FIGURES 1–3, when power or torque is being transmitted through the transmission, sun gear 2 will adjust itself in conformity with the resultant tooth pressures acting on it by virtue of its meshing contact with planet gears 3. It should be noted that since sun gear 2 is not supported by bearings but by planet gears 3, it will be capable of radial movement in order to maintain equal load distribution among the planet gears. In addition to possible radial shifting, this self-adjustment of sun gear 2 will generally cause obliquity or inclination of its axis. In other words, a relative angular position of the axis of sun gear 2 and its extension 2*a* will be effected with respect to the axis of planet gears 3. This will mean that the teeth on sun gear 2 will be angularly related to the teeth on the planet gears. This last-mentioned angular positioning would normally impair the proper rolling engagement between the flanks of the sun gear and planet gear teeth, and would furthermore cause edging, noisy running, and shorten the life of the gears. However, due to the slightly crowned shape of the flanks of the planet gear teeth in conformity with the present invention, the sun gear teeth and planet gear teeth would still continue to move properly into and out of mesh, the connection between these teeth being somewhat similar to a universal joint in this respect.

The engagement of the slightly crowned teeth on planet gears 3 with orbit gear 6 will have a similar effect in that relative angularity between the axes of the orbit gear and the planet gears will be permitted with the teeth of these gears still maintaining their correct meshing relationship. Here again, the engagement of the planet gear teeth and orbit gear teeth in this manner will create an effect similar to that of a universal joint permitted limited relative angular movement.

It should be noted that in the case of both the sun gear and orbit gear, the coupling teeth 10 and 12 respectively on the extensions of these gears may likewise change their angular position relative to coupling teeth 9 and 13. Sufficient clearance is of course provided between these two sets of coupling teeth to permit such angular shifting to take place. However, this angular shifting will not affect the proper functioning of teeth 9, 10, 12 and 13 since each set of coupling teeth will stay in constant mesh without any involute or rolling action such as takes place between the gear teeth. The fact that each set of coupling teeth (9, 10 and 12, 13) acts as a form of universal coupling will permit radial shifting of sun gear 2 and orbit gear 6 with respect to the shaft axis in addition to the angular shifting described above. Flexible arms 16*a* formed by the apertured portions in extension 11 of orbit gear 6 will permit bending or distortion of the connection between orbit gear 6 and ring 14. This will insure that extension 11 will not hinder elastic deformations of orbit gear 6 which may occur due to the effect of radial components of the gear tooth forces. This flexible construction, which in itself is known, will thus aid in properly distributing the load on the planet gears. It should be understood that the shape of apertured portions 16 could be varied to suit particular conditions, and could be replaced by bores or the like.

As indicated above, instead of crowning the teeth of planet gears 3, the teeth of sun gear 2 and orbit gear 6, or of the entire planetary gear transmission, may be crowned without affecting the principles of the present invention. If, in conformity with the embodiment shown in FIGURES 1–3, only planet gears 3 are provided with slightly crowned toothed flanks, the advantage is obtained that sun gear 2 and orbit gear 6 can move in an axial direction without thereby causing a change of position of the mesh of their teeth with respect to planet gears 3. This may be of importance, for instance, when directly connecting a planetary gear transmission constructed according to the invention with a steam turbine rotor, because such rotors, when in operation, generally are subjected to elongation which then leads to a change in axial position of the central gear coupled thereto.

As discussed above, the link-like connections for sun gear 2 and orbit gear 6 are in the form of coupling tooth sets 9, 10, and 12, 13. It should be understood, however, that any other connections, for example, rubber connections, may be alternatively used, provided such connections allow limited angular positioning of the respective axes. It should also be noted that the invention is applicable to planetary gear transmissions having spur or straight teeth as well as those with helical teeth.

FIGURE 4 illustrates another embodiment of the invention generally similar in principle to that described above, but in which the gear carrier is fixed. In this embodiment, a casing 17 is provided, this casing carrying a first shaft 19 and a second shaft 21 which are rotatably mounted at opposite ends of the casing in co-axial relationship. A sun gear 22 is disposed within casing 17 and has an extension 23, the outer end of this extension carrying coupling teeth 24. The inner end of shaft 19 has internal coupling teeth 25 which interfit with coupling teeth 24 to provide a flexible connection between sun gear 22 and shaft 19.

A plurality of non-central gears 26 are provided, these gears being equidistantly spaced around sun gear 22 so that the sun gear is supported by the non-central gears. Each planet gear 26 is rotatably mounted on a shaft 27 which is supported between a wall 28 of the casing and a carrier 29 secured to said wall. It will thus be seen that non-central gears 26 are on fixed axes with respect to the casing. An internally toothed orbit gear 31 surrounds and is supported by non-central gears 26, and has a flexible extension 32 similar to that of the previous embodiment. The other end of extension 32 carries a coupling tooth ring 33 in which are formed a plurality of coupling teeth 34. These teeth interfit with a plurality of coupling teeth 35 on an enlarged disk 36 formed at the inner end of shaft 21.

Preferably, as in the previous embodiment, the teeth on non-central gears 26 are slightly crowned in a longitudinal direction, thus providing a form of limited universal joint at their connections with sun gear 22 and orbit gear 31 respectively. Since these gears have flexible connections in the form of coupling teeth 24, 25 and 34, 35, with their respective shafts 19 and 21, both radial and angular shifting movement of sun gear 22 and orbit gear 31 will be permitted with respect to non-central gears 26, for the reasons described with respect to the previous embodiment.

While it will be apparent that the preferred embodiments of the invention disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In a gear transmission, a casing member, first and second shaft members rotatably supported by said casing